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(54) **Film-type power resistor**

Leistungsschichtwiderstand

Résistance à puissance en couche

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- **PATENT ABSTRACTS OF JAPAN vol. 12, no. 493 (E-697)22 December 1988 & JP-A-63 205 935 (TOSHIBA) 25 August 1988**
- **PATENT ABSTRACTS OF JAPAN vol. 10, no. 347 (E-457)21 November 1986 & JP-A-61 150 354 (TOSHIBA) 9 July 1986**

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Description

The flat substrates employed in many film-type power resistors are, preferably, thin, being made of a ceramic. It has long been known in the prior art to embed such a substrate, having a resistive film thereon, in a body of ,synthetic resin, with no thought of any heatsink action. Prior-art power resistors of the type indicated rely, for cooling, solely on passage of air over the synthetic resin body, and on conduction of heat through the leads that are connected to the resistive film. Such prior-art resistors have low power ratings.

GB-A-2050705 discloses a film-type power resistor in which the resistor is formed on a ceramic chip. The resistive film, terminal leads and ceramic chip are all encapsulated in a resin body. It is also known in semiconductor devices to mount the semiconductor chip on a metal heat sink and then mould resin around the semiconductor device to leave the metal heat sink exposed. One example of this is given in JP-A-6 3205 935.

According to the present invention a film type power resistor comprising:

(a) a flat, non-metal chip having an upper surface and a flat lower surface, having a high dielectric strength, and having relatively high thermal conductivity for a non-metal,

(b) a resistive film applied to said upper surface of said chip,

(c) terminals connected mechanically to said upper surface of said chip and connected electrically to said resistive film, and

(d) a moulded electrically insulating body embedding said chip and portions of said terminals adjacent said chip,

is characterised in that only said upper surface and edges of said chip are embedded in said moulded electrically insulating body and in that said lower surface of said chip lies flush with a bottom surface of said moulded electrically insulating body.

Since the lower surface of the non-metal chip is not covered by said moulded electrically insulating body and lies flush with the bottom surface of the body it allows engagement of the chip with a chassis or heatsink on which the device is mounted. A bolthole is preferably provided through the body to receive a bolt which firmly secures the body to a chassis or external heatsink.

The terminals are embedded in the body and are mechanically and electrically connected to the upper side of the chip. The terminals are so constructed as to aid substantially in anchoring the substrate in the body. The leads are adapted to permit some angular movement of the chip in the mold, so that the bottom surface of the chip may be fully exposed for flatwise engagement with the chassis.

A particular example of a power resistor in accordance with the present invention will now be described with reference to the accompanying drawings, in which:-

Figure 1 is an isometric view of a film-type power resistor incorporating the present invention;

Figure 2 is another isometric view thereof, as seen from the other end, and with the synthetic resin body shown in phantom lines so as to reveal certain internal components of the resistor;

Figure 3 is a longitudinal section on line 3-3 of Figure 2;

Figure 4 is an enlarged fragmentary view of the readily-bendable portion of a terminal or lead;

Figure 5 is a plan view of the substrate, after combination trace and pad films have been applied thereto;

Figure 6 is a view corresponding to Figure 5 but showing resistive film applied to the substrate or chip and over edge regions of the trace and pad films; and,

Figure 7 is a view corresponding to Figure 6 and also showing a protective coating applied over the resistive film, and further showing in phantom lines the terminals associated with the combination trace and pad films and thus with the resistive film and the substrate.

Referring to Figure 1, the resistor comprises an elongate rectangular synthetic resin body 10 having a flat upper surface 11 that is substantially parallel to a flat lower or bottom surface 12 (Figure 3). Lower surface 12 of the resin body is not continuous but instead has provided therein, in "framed" relationship by lower regions of the resin body, a flat substrate or chip 13. Substrate 13 has substantially parallel top and bottom surfaces, the bottom surface being denoted by the reference numeral 14 and being flush with surrounding regions of the lower surface 12 of body 10.

Substrate 13 is therefore embedded in and encompassed on all sides by the resin body 10, except for bottom substrate surface 14 that is adapted to engage a chassis or heatsink in flatwise heat-transfer relationship. The substrate or chip 13 is relatively close to one end of body 10 (the left end in Figures 2 and 3) and is spaced a substantial distance from the other end thereof (the right end in such figures). Bolthole 16 is extended through body 10 with its axis perpendicular to such body and to substrate 13, in such relationship that no part of the bolthole is close to the substrate. Bolthole 16 is adapted to receive a bolt (not shown) that extends through a corresponding hole in a flat metal chassis region (not shown) so as to firmly clamp bottom surface 14 of substrate 13 against the flat chassis region in heat transfer relationship.

Although substrate 13 is not spaced equal distances 20 from the ends of body 10, it is spaced equal distances from the sides of such body. One such side space is shown at 15 in Fig. 2, being the mirror image of the side space (not shown) that is parallel thereto.

As described subsequently relative to Figs. 5-7, the upper surface of substrate 13 has combination termination traces and pads 17 thereon, also has resistive film 18 thereon, and also has a protective coating 19 thereon. Furthermore, terminals or leads are secured mechanically and electrically to coatings on the upper surface of the substrate, as next described. It is emphasized that the substrate 13 accordingly acts not only as a substrate but as an electrical insulator or dielectric element, and further acts as a heatsink. It further acts as a spacer to ensure that no portions of the leads come closer to the bottom surface of the resistor element than is the top surface of the substrate/electrical insulator/ heatsink/ spacer 13.

Although element 13 is a good electrical insulator, it is selected to have relatively high thermal conductivity for a nonmetal element. The preferred substance for substrate or chip 13 is aluminum oxide ceramic. Less preferred materials are beryllium oxide and aluminum nitride.

Elongate metal terminals or leads 21,22 are provided as best shown in Figure 2, being mirror images of each other about a vertical plane containing the longitudinal axis of body 10. The terminals are preferably bendable metal stampings.

Each terminal 21,22 has an elongate narrow end section 23 the length of which is more than half the length of ceramic 13, and which has a tab 24 on its extreme inner end. The narrow end sections 23 of the terminals are electrically and mechanically connected to the combination traces and pads 17, in such relationship that the extreme inner ends of elements 23, including tabs 24, are not directly above the substrate but instead are cantilevered therefrom as best shown in Figures 2, 3 and 7.

At the portions of end sections 23 remote from tabs 24, the terminals 21,22 have integral riser portions 26 that extend upwardly for a considerable distance from ceramic 13 but are still spaced, at their upper ends, a substantial distance below upper surface 11 of body 10. The riser portions 26, in turn, connect to sections 27 that are parallel to the narrow sections 23 but in a substantially higher plane. Sections 27 extend outwardly from body 10 to shoulders 28. At such shoulders, the terminals narrow to provide prongs 29 for connection to conventional terminals or sockets.

As shown in Figures 2-4, risers 26 are either formed relatively thin or have the illustrated notches 31 provided therein so that the risers are relatively readily bendable. This aids, as next described, in causing the ceramic chip element 13 to lie flat on the bottom of mold cavity during transfer molding of the body 10. Accordingly, and as shown in Figure 3, the bottom surface 14 of the element 13 is flush with bottom surface 12 of the body 10 for effective high thermal-conductivity flatwise engagement with a flat chassis region.

The result is a resistor-chassis combination in which the resistor has a low cost but high power rating. There is nothing between the resistive film 18 and the chassis except the ceramic chip 13 that is itself part of the film-type resistor, and except (in many cases) a thermal grease that is applied by the customer. On the other hand, the present resistor is less rugged than are power resistors wherein the bottom surface is metal or high-thermal conductivity epoxy.

To mold the present resistor, the below-described subcombination comprising the ceramic element 13, terminals 21,22, etc., is disposed relative to the bottom section of a mold (not shown) in such manner that the undersides of terminals 21,22 rest on such bottom section in a predetermined position at a cavity edge, the terminals being suitably held down. The ceramic chip 13 is thus positioned in the bottom portion of the mold cavity at a predetermined location. The riser 26 and other parts are so correlated in size with the mold cavity that the bottom chip surface 14 rests on the bottom cavity wall when the terminals rest on the mold section edge.

The upper portion of the mold incorporates pins adapted to engage the upper surfaces of narrow end sections 23 of terminals 21,22, thus forcing such end sections as well as the underlying ceramic element down until bottom surface 14 of the ceramic is in close flatwise engagement with the bottom wall of the mold cavity. Because of the presence of the thin regions or notches 31 in risers 26, the terminals 21,22 can bend in response to mold closing, thus facilitating or making possible the close flatwise engagement between ceramic surface 14 and the bottom cavity wall in the vast majority of instances.

Accordingly, the hot synthetic resin, which is preferably heated epoxy powder, does not penetrate between ceramic surface 14 and the mold wall during the transfer molding operation. Instead, it effectively surrounds or frames the edges of the ceramic chip as well as embedding all portions of terminals 21,22 except prongs 29 and the terminal regions adjacent shoulders 28.

Because of the presence of the tabs 24 and adjacent terminal regions, and because of the presence of the terminal sections 27, and because of the fact that terminal sections 23 are mechanically connected to chip 13 as described below, the chip 13 is effectively anchored in the synthetic resin body 10.

The indicated pins in the upper portion of the mold 15 leave notches or recesses 32 in the resin body at the corners thereof, as best shown in Figure 1.

The parting line between the upper and lower mold sections is shown at 33, being in the same plane as that of the lower surfaces of terminal portions 27 and 29.

Referring next to Figure 5, the ceramic chip 13 has applied to the upper surface thereof two combination traces and pads 17. The traces and pads are elongate rectangles, are preferably applied by screen-printing, and lie generally along opposite edge portions of the chip 13 in parallel relationship to each other. The com-

bination traces and pads 17 are adapted to, and later do, extend longitudinally of the resistor body 10. Following such screenprinting, the ceramic element is fired.

Referring next to Figure 6, a thick film 18 of resistive material is screen-printed onto ceramic element 13. The edge regions (top and bottom in Figure 6) of resistive film 18 overlap somewhat the combination traces and pads 17, as illustrated. After being screen-printed onto the substrate, the ceramic element is again fired. The preferred resistive material comprises electrically-conductive complex metal oxides in a glass matrix, and is fired at a temperature in excess of 800 degrees C.

There is then screen printed onto the entire upper surface of resistive film 18, and for slight distances past such film, a protective coating 19 preferably comprising glass. A relatively low melting point glass frit is screen-printed onto the substrate as stated, and is fired at a temperature of about 500 degrees C. The major difference between the firing temperature of the resistive film 18, and that of the glass 19, is such that firing of the glass does not adversely affect the resistive film 18.

There is then screen-printed onto those portions of combination traces and pads 17 not covered by glass 19 a solder composition. Alternatively, the solder is applied by dipping. This composition preferably comprises 96.5% tin and 3.5% silver. Although only a portion of the solder is employed for securing the terminals as next stated, the entire exposed upper surface portions of films 17 are solder coated in order to improve their electrical conductivity.

As the next step, the terminals 21,22 are clamped to substrate 13, with the sections 23 (Figure 2) of the terminals firmly seated on the above-indicated solder (not shown) that was applied to combination traces and pads 17. Then, baking is effected in order to melt the solder and thereby secure the terminals to the coated ceramic element 13. The terminals are thus mechanically and electrically connected to such element. Thereafter, molding is effected as stated relative to Figures 1 to 3.

Before molding takes place, the resistor is trimmed by laser scribing a line 34 of appropriate length and width to achieve the desired resistance value.

As a specific example, each terminal 21, 22 is 0.020 inch (0.5 mm) thick. The sections 23 are 0.035 inch (0.8 mm) wide. The height of each riser 26, from the bottom surface of section 23 to the bottom surface of section 27, is 0.060 inch (1.5 mm). The molded body 10 is 0.150 inch (3.8 mm) thick, with the parting line 33 being 0.090 inch (2.3 mm) from bottom surface 12. The ceramic chip 13 is about 0.030 inch (0.75 mm) thick, 0.32 inch (8 mm) wide and 0.35 inch (9 mm) long. Body 10 is 0.410 inch (10.3 mm) wide and 0.640 inch (16 mm) long.

Claims

1. A film-type power resistor comprising :

(a) a flat, non-metal chip (13) having an upper surface and a flat lower surface, having a high dielectric strength, and having relatively high thermal conductivity for a non-metal,
(b) a resistive film (18) applied to said upper surface of said chip (13),
(c) terminals (21, 22) connected mechanically to said upper surface of said chip (13) and connected electrically to said resistive film (18), and
(d) a moulded electrically insulating body (10) embedding said chip (13) and portions of said terminals (21, 22) adjacent said chip (13),

characterised in that only said upper surface and edges of said chip (13) are embedded in said moulded electrically insulating body (10) and in that said lower surface of said chip lies flush with a bottom surface of said moulded electrically insulating body (11).

2. A film-type power resistor according to claim 1, in which the moulded electrically insulating body (10) includes a bolthole (16), spaced apart from the chip (13) for receiving a bolt to join the resistor to a chassis.

3. A film-type power resistor according to claim 1 or 2, in which the non-metal chip (13) is a ceramic such as aluminium oxide, beryllium oxide, or aluminium nitride.

4. A film-type power resistor according to any one of the preceding claims, in which the body (10) is of a high thermal conductivity resin.

5. A film-type power resistor according to claim 4, in which the body (10) is moulded from an epoxy resin.

6. A film-type power resistor according to any one of the preceding claims, in which the resistive film (18) is a thick film which is screen printed on the upper surface of the chip (13).

7. A film-type power resistor according to any one of the preceding claims, in which the terminals (21, 22) include a riser (26) extending away from the non-metal chip (13), and elongate sections (27) extending away from the chip in a plane substantially parallel to, and spaced apart from, the upper surface of the non-metal chip (13).

8. A film-type power resistor according to claim 7, in which the riser (26) is readily bendable prior to moulding of the body (10).

9. A film-type power resistor according to claim 8, in which the riser (26) includes a notch (31) to give the

required bendability.

10. A film-type power resistor according to any one of the preceding claims, in which traces and pads are screen printed onto the upper surface of the non-metal chip (13), and the terminals (21, 22) are soldered to the traces.

11. A film-type power resistor according to any one of the preceding claims, in which the terminals (21,22) include tabs (24) to increase the strength of embedment in the body.

12. A film-type power resistor according to any one of the preceding claims, in which the terminals (21, 22) include two elongate parallel sections, each having one part (23) seated on the upper surface of the chip (13), being the part mechanically connected to the chip (13).

13. A film-type power resistor according to any one of claims 2 to 12, in which the non-metal chip (13) is generally square and is provided substantially at one end of the body (110, and the bolthole (16) is provided substantially at the other end of the body (10).

14. A film-type power resistor according to any one of claims 2 to 13, in which the bolthole (16) extends in a plane transverse to the plane of the upper surface of the non-metal chip (13).

15. A film-type power resistor according to any one of the preceding claims, in which a trimming slot (34) is provided through the resistive film (18).

16. A film-type power resistor according to any one of the preceding claims, in which a barrier coating (19) is provided between the resistive film (18) and the body (10).

17. A film-type power resistor according to claim 15, in which the barrier coating (19) is glass, and has a firing temperature lower than that of the resistive film (18).

Patentansprüche

1. Leistungsschichtwiderstand, umfassend:

(a) einen ebenen, nicht-metallischen Chip (13), der eine obere Fläche besitzt und der eine hohe dielektrische Festigkeit, sowie eine relativ hohe thermische Leitfähigkeit für ein Nicht-Metall besitzt,
(b) eine Widerstandsschicht (18), die auf die obere Fläche des Chips (13) aufgetragen ist,
(c) Anschlüsse (21,22), die mechanisch mit der Oberfläche des Chips (13) und elektrisch mit der Widerstandsschicht (18) verbunden sind, und
(d) ein geformtes, elektrisch isolierendes Gehäuse (10), das den Chip (13) und Teile der Anschlüsse (21,22), die an den Chip (13) angrenzen, einbettet,

dadurch gekennzeichnet, daß lediglich die obere Fläche und die Kanten des Chips (13) im geformten, elektrisch isolierenden Gehäuse (10) eingebettet sind, und daß die untere Fläche dieses Chips bündig mit der Bodenfläche des geformten elektrisch isolierenden Gehäuses (10) verläuft.

2. Leistungsschichtwiderstand nach Anspruch 1, bei dem das elektrisch isolierende Formgehäuse (10) ein Bolzen- oder Schraubloch (16) umfaßt, das vom Chip (13) beabstandet ist, um einen Bolzen oder eine Schraube aufzunehmen, um den Widerstand an einem Chassis zu befestigen.

3. Leistungsschichtwiderstand nach Anspruch 1 oder 2, bei dem der nicht-metallische Chip (13) aus einem keramischen Material besteht.

4. Leistungsschichtwiderstand nach irgendeinem der vorstehenden Ansprüche, bei dem das Gehäuse (10) aus einem Harz mit einer hohen thermischen Leitfähigkeit besteht.

5. Leistungsschichtwiderstand nach Anspruch 4, bei dem das Gehäuse (10) aus einem Epoxidharz geformt ist.

6. Leistungsschichtwiderstand nach irgendeinem der vorstehenden Ansprüche, bei dem die Widerstandsschicht (18) ein dicker Film ist, der auf die obere Fläche des Chips (13) per Siebdruck aufgetragen ist.

7. Leistungsschichtwiderstand nach irgendeinem der vorstehenden Ansprüche, bei dem die Anschlüsse (21,22) eine Treppe (26) umfassen, die sich weg vom Nicht-Metallchip (13) erstreckt, und längliche Abschnitte (27), die sich weg vom Chip in einer Ebene im wesentlichen parallel zu und beabstandet von der oberen Fläche des Nicht-Metallchips (13) erstrecken.

8. Leistungsschichtwiderstand nach Anspruch 8, bei dem die Treppe (26) eine Kerbe (31) umfaßt, um die erforderliche Biegbarkeit herzustellen.

9. Leistungsschichtwiderstand nach Anspruch 8, bei dem die Treppe (26), vor dem Formen des Gehäuses (10) leicht biegbar ist.

10. Leistungsschichtwiderstand nach irgendeinem der vorstehenden Ansprüche, bei dem Spuren und Polster auf die obere Fläche des Nicht-Metallchips (13) per Siebdruck aufgetragen sind, und wobei die Anschlüsse (21,22) an die Spuren angelötet sind.

11. Leistungsschichtwiderstand nach irgendeinem der vorstehenden Ansprüche, bei dem die Anschlüsse (21,22) Zungen oder Laschen (24) umfassen, um die Festigkeit der Einbettung im Gehäuse zu erhöhen.

12. Leistungsschichtwiderstand nach irgendeinem der vorstehenden Ansprüche, bei dem die Anschlüsse (21,22) zwei längliche, parallel verlaufende Abschnitte umfassen, von denen jeder einen Teil (23) besitzt, der an der oberen Fläche des Chips (13) sitzt, wobei dieser Teil mechanisch mit dem Chip (13) verbunden ist.

13. Leistungsschichtwiderstand nach irgendeinem der vorstehenden Ansprüche 2 bis 12, bei dem der Nicht-Metallchip (13) generell quadratisch oder rechteckig ist und im wesentlichen an einem Ende des Gehäuses (10) vorgesehen ist, und wobei das Bolzenloch (16) im wesentlichen am anderen Ende des Gehäuses (10) vorgesehen ist.

14. Leistungsschichtwiderstand nach irgendeinem der Ansprüche 2 bis 13, bei dem sich das Bolzen- oder Schraubloch (16) in einer Ebene transversal zur Ebene der oberen Fläche des Nicht-Metallchips (13) erstreckt.

15. Leistungsschichtwiderstand nach irgendeinem der vorstehenden Ansprüche, bei dem ein Trimmschlitz (34) durch die Widerstandsschicht (18) hindurch vorgesehen ist.

16. Leistungsschichtwiderstand nach irgendeinem der vorstehenden Ansprüche, bei dem ein Grenzüberzug (19) zwischen der Widerstandsschicht (18) und dem Gehäuse (10) vorgesehen ist.

17. Leistungsschichtwiderstand nach Anspruch 15, bei dem der Grenzüberzug (19) Glas ist und eine Zündtemperatur besitzt, die geringer ist als die der Widerstandsschicht (18).

Revendications

1. Résistance de puissance du type à couche comprenant :

   (a) une puce non métallique, plate, (13) comportant une face supérieure et une face inférieure plate, ayant une forte rigidité diélectrique, et ayant une conductivité thermique relativement grande pour une matière non métallique ;
   (b) une couche résistive (18) appliquée à ladite face supérieure de ladite puce (13) ;
   (c) des bornes (21, 22) raccordées mécaniquement à ladite face supérieure de ladite puce (13) et raccordées électriquement à ladite couche résistive (18) ;
   (d) un corps moulé (10) isolant de l'électricité enrobant ladite puce (13) et des parties desdites bornes (21, 22) adjacentes à ladite puce (13) ;

   caractérisée en ce que seuls ladite face supérieure et lesdits bords de ladite puce (13) sont enrobés dans ledit corps moulé (10) isolant de l'électricité, et en ce que ladite face inférieure de ladite puce se trouve à fleur d'une face inférieure dudit corps moulé (11) isolant de l'électricité.

2. Résistance de puissance du type à couche selon la revendication 1, dans laquelle le corps moulé (10) isolant de l'électricité comprend un trou de boulon (16), espacé de la puce (13) pour recevoir un boulon pour lier la résistance à un châssis.

3. Résistance de puissance du type à couche selon la revendication 1 ou 2, dans laquelle la puce non métallique (13) est une céramique comme de l'oxyde d'aluminium, de l'oxyde de béryllium, ou du nitrure d'aluminium.

4. Résistance de puissance du type à couche selon l'une quelconque des revendications précédentes, dans laquelle le corps (10) est fait de résine à forte conductivité thermique.

5. Résistance de puissance du type à couche selon la revendication 4, dans laquelle le corps (10) est moulé à partir d'une résine époxy.

6. Résistance de puissance du type à couche selon l'une quelconque des revendications précédentes, dans laquelle la couche résistive (18) est une couche épaisse qui est sérigraphiée sur la face supérieure de la puce (13).

7. Résistance de puissance du type à couche selon l'une quelconque des revendications précédentes, dans laquelle les bornes (21, 22) comportent une partie montante (26) s'écartant de la puce non métallique (13), et des sections allongées (27) s'écartant de la puce dans un plan sensiblement parallèle à, et espacé de, la surface supérieure de la puce non métallique (13).

8. Résistance de puissance du type à couche selon la

revendication 7, dans laquelle la partie montante (26) fléchit facilement avant le moulage du corps (10).

9. Résistance de puissance du type à couche selon la revendication 8, dans laquelle la partie montante (26) comprend une encoche (31) pour donner la flexibilité voulue.

10. Résistance de puissance du type à couche selon l'une quelconque des revendications précédentes, dans laquelle des rubans et des plages de connexion sont sérigraphiés sur la face supérieure de la puce non métallique (13), et dans laquelle les bornes (21, 22) sont soudées aux rubans.

11. Résistance de puissance du type à couche selon l'une quelconque des revendications précédentes, dans laquelle les bornes (21, 22) comportent des pattes (24) pour augmenter la force d'enrobage dans le corps.

12. Résistance de puissance du type à couche selon l'une quelconque des revendications précédentes, dans laquelle les bornes (21, 22) comportent deux sections parallèles allongées, ayant chacune une partie (23) appuyée sur la face supérieure de la puce (13), qui est la partie raccordée mécaniquement à la puce (13).

13. Résistance de puissance du type à couche selon l'une quelconque des revendications 2 à 12, dans laquelle la puce non métallique (13) est globalement carrée et est placée sensiblement à une extrémité du corps (110), et dans laquelle le trou de boulon (16) est placé sensiblement à l'autre extrémité du corps (10).

14. Résistance de puissance du type à couche selon l'une quelconque des revendications 2 à 13, dans laquelle le trou de boulon (16) s'étend dans un plan transversal au plan de la patte supérieure de la puce non métallique (13).

15. Résistance de puissance du type à couche selon l'une quelconque des revendications précédentes, dans laquelle une fente d'ajustement (34) est prévue dans la couche résistive (18).

16. Résistance de puissance du type à couche selon l'une quelconque des revendications précédentes, dans laquelle un revêtement (19) formant barrière est placé entre la couche résistive (18) et le corps (10).

17. Résistance de puissance du type à couche selon la revendication 15, dans laquelle le revêtement (19) formant barrière est du verre, et a une température de cuisson inférieure à celle de la couche résistive (18).

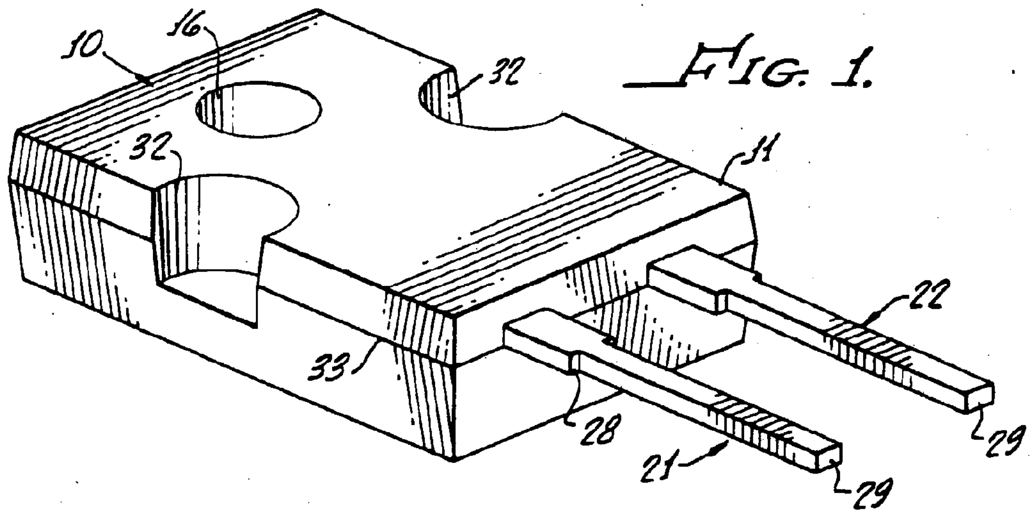


FIG. 1.

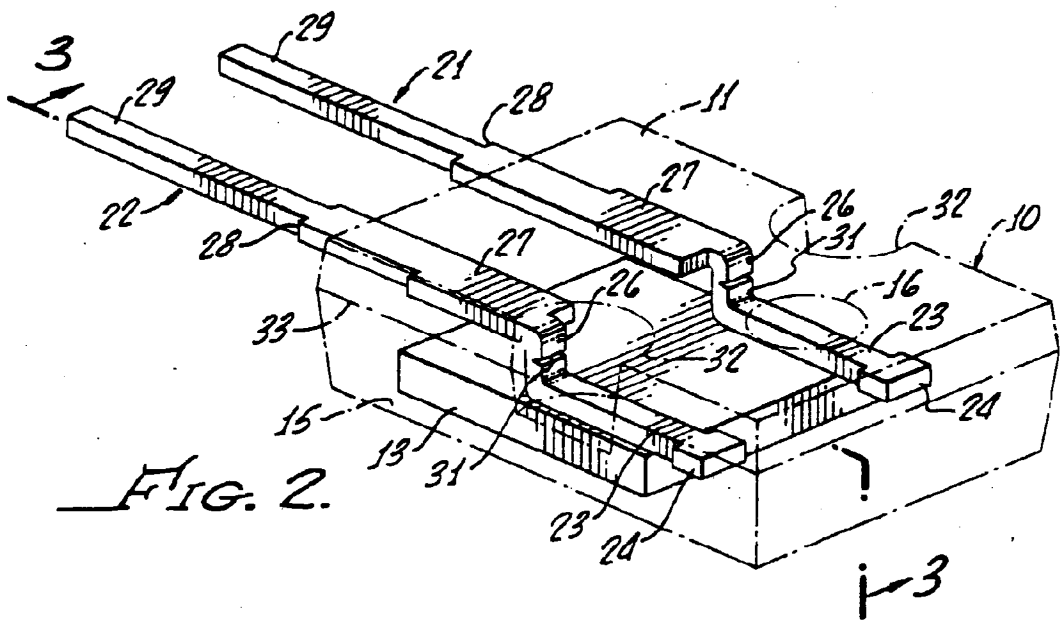
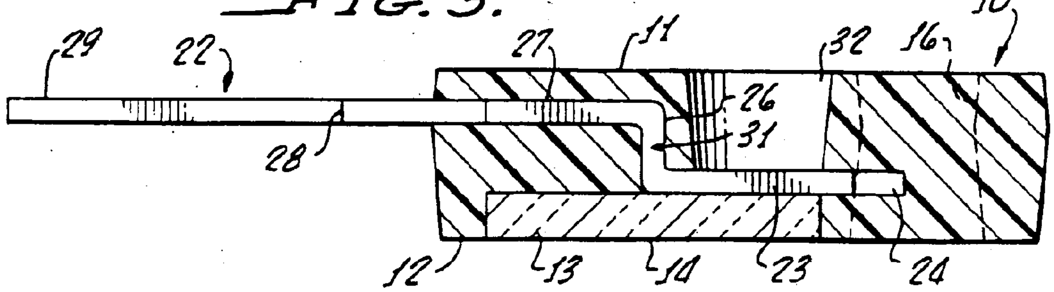


FIG. 2.

FIG. 3.



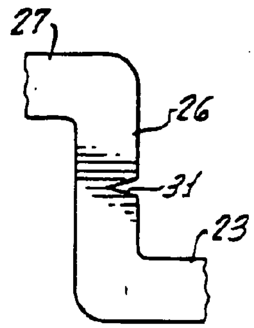


FIG. 4.

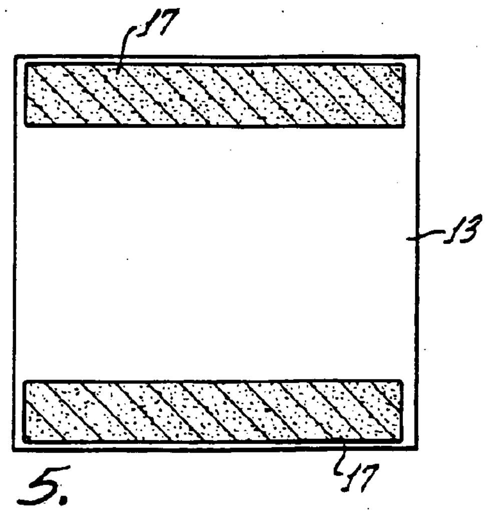


FIG. 5.

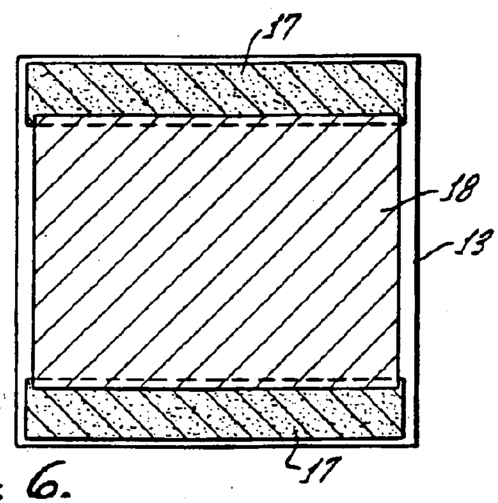


FIG. 6.

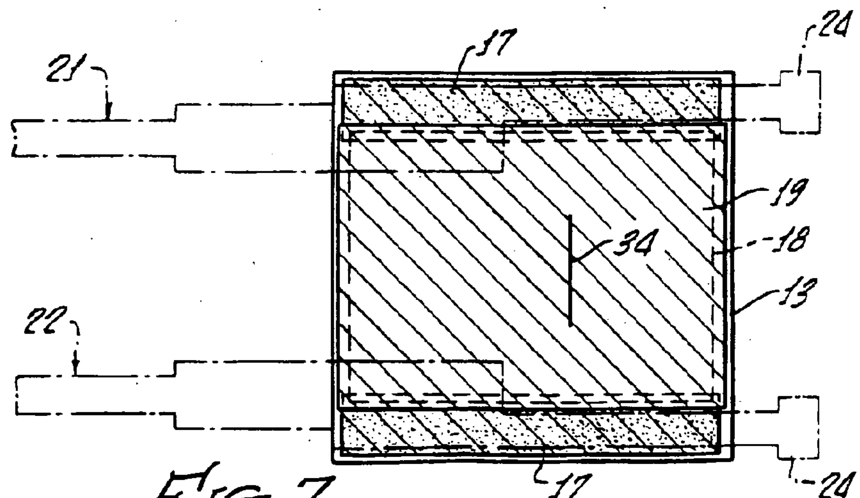


FIG. 7.